<u>CLAIMS</u>

1. A plasma processing apparatus, comprising:

a processing chamber having walls and a lid, the walls and the lid both have an internal surface and an exterior surface, said processing chamber being used to process a substrate using a plasma produced by process gases; and

a thermal management system thermally coupled to an exterior surface of said processing chamber, said thermal management system including at least one combination heating and cooling block that is controlled to regulate a temperature internal to said processing chamber.

2. A plasma processing apparatus as recited in claim 1, wherein said combination heating and cooling block is a sandwich structure and comprises:

a heater element;

a cooling element; and

a thermal break element between said heater element and said cooling element.

3. A plasma processing apparatus as recited in claim 2, wherein said heater element is thermally coupled to the exterior surface of said processing chamber, and said cooling element thermally couples to the exterior surface of said processing chamber through said thermal break and said heater element.

4. A plasma processing apparatus as recited in claim 2, wherein said heater element is thermally coupled to the exterior surface of said processing chamber, and said cooling element thermally couples to the exterior surface of said processing chamber and said heater element through said thermal break.

5. A plasma processing apparatus as recited in claim 4, wherein said combination heating and cooling block is thermally coupled to one of the walls of said processing chamber.

6. A plasma processing apparatus as recited in claim 5, wherein the walls of said processing chamber is comprised of a thermally and/or electrically bonded sandwich of materials.

7. A plasma processing apparatus as recited in claim 5, wherein the walls of said processing chamber is comprised of a thermally and/or electrically bonded sandwich of materials formed by tiling.

8. A plasma processing apparatus as recited in claim 4, wherein said combination heating and cooling block is thermally coupled to the lid of said processing chamber.

9. A plasma processing apparatus as recited in claim 8,

wherein said processing apparatus further comprises an RF coil used to generate RF energy to ignite a plasma, and

wherein at least one of said heater element and said cooling element include slots to minimize RF coupling from said RF coil.

10. A plasma processing apparatus as recited in claim 2,

wherein the sandwich structure for said combination heating and cooling block further comprises a conformal gasket, and

wherein said heater element is thermally coupled to the exterior surface of said processing chamber through said conformal gasket, and said cooling

element is thermally coupled to the exterior surface of said processing chamber through said thermal break, said heater element and said conformal gasket.

11. A plasma processing apparatus as recited in claim 1, wherein at least an inner surface of the walls and the lid of said processing chamber are ceramic.

12. A plasma processing apparatus as recited in claim 11, wherein the ceramic is SiC.

13. A plasma processing apparatus as recited in claim 2,

wherein at least an inner surface of the walls and the lid of said processing chamber are ceramic, and

wherein said heater element and said cooling element are metal.

14. A plasma processing apparatus as recited in claim 13,

wherein said thermal break and said conformal gasket is rubber.

15. A plasma processing apparatus as recited in claim 14, wherein the thermal conductivity of said thermal gasket is significantly greater than the thermal conductivity of said thermal break.

16. A plasma processing apparatus as recited in claim 1, wherein said at least one combination heating and cooling block is spring biased against the exterior surface of said processing chamber.

17. A plasma processing apparatus as recited in claim 13,

wherein the spring biasing of said at least one combination heating and cooling block is provided by a spring, and

wherein said at least one combination heating and cooling block can be removed from its thermally coupled position with the exterior surface of said processing chamber by retracting the spring.

18. A semiconductor manufacturing apparatus, comprising:

a plasma processing chamber formed by walls and a bottom surface;

a sealing lid removably coupled to a top portion of the walls of said plasma processing chamber;

an RF powered electrode provided on an upper surface of said sealing lid;

at least one temperature sensor coupled to said sealing lid or said plasma processing chamber;

a first heating and cooling unit coupled to the upper surface of said sealing lid; and

a second heating and cooling unit coupled to an outer surface of the walls of said plasma processing chamber.

19. A semiconductor manufacturing apparatus as recited in claim 18, wherein said first heating and cooling unit is configured to substantially avoid coupling of RF energy from said RF powered electrode into said first heating and cooling unit.

20. A semiconductor manufacturing apparatus as recited in claim 18, wherein said first heating and cooling unit includes slots to substantially avoid coupling of RF energy from said RF powered electrode into said first heating and cooling unit.

21. A semiconductor manufacturing apparatus as recited in claim 18, wherein each of said first and second heating and cooling units is a sandwich structure and comprises:

a heater element;

a cooling element; and

a thermal break element between said heater element and said cooling element.

22. A semiconductor manufacturing apparatus as recited in claim 21, wherein said heater element of said first heating and cooling unit is thermally coupled to an exterior surface of said sealing lid of said plasma processing chamber, and said cooling element of said first heating and cooling unit is thermally coupled to the exterior surface of said sealing lid of said plasma processing chamber through said thermal break and said heater element.

23. A method for providing temperature control to a plasma processing chamber of a plasma processing apparatus, said method comprising:

directly or indirectly measuring temperature internal to the plasma processing chamber;

comparing the measured temperature to a target temperature;

heating the plasma processing chamber by heating a thermal control block that is thermally coupled to the plasma processing chamber; and

cooling the plasma processing chamber by actively cooling the thermal control block.

24. A method as recited in claim 23, wherein the thermal control block thus is able to cool the plasma processing chamber through the same thermal control

block that is able to heat the plasma processing chamber, thereby providing more uniform temperature profile to the plasma processing chamber.

25. A method as recited in claim 23, wherein the thermal control block includes at least a heater element and a cooling element, and

wherein said cooling is provided by the cooling element through the heating element.

26. A method as recited in claim 25, wherein the thermal control block further includes a thermal break element coupled between the heater element and the cooling element.

27. A method as recited in claim 23, wherein said method further comprises:

removably biasing the thermal control block against a portion of the plasma processing chamber.

28. A plasma processing apparatus, comprising:

a processing chamber having walls and a lid, the walls and the lid both have an internal surface and an exterior surface, said processing chamber being used to process a substrate using a plasma produced by process gases; and

means for regulating a temperature internal to said processing chamber by heating said processing chamber with a heater element when the internal temperature is below a lower target temperature and cooling said processing chamber, through the heater element, with a cooling element when the internal temperature is above an upper target temperature.

29. A combination heating and cooling block having a sandwich construction, said combination heating and cooling block comprises:

a heater element;

a cooling element; and

a thermal break element between said heater element and said cooling element.

30. A combination heating and cooling plate as recited in claim 29, wherein said combination heating and cooling plate comprises:

a conformal gasket attached to said heater element.

31. A combination heating and cooling plate as recited in claim 30, wherein said thermal break is a rubber product, and wherein said heater element and said cooling element are metal.